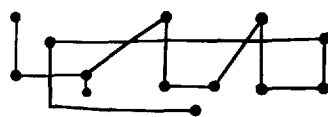


THROUGH
THE SENSORY LOOKING-GLASS:
THE AESTHETIC
AND SERIAL FOUNDATIONS
OF *GESANG DER JÜNGLINGE*



PASCAL DECROUPET
AND
ELENA UNGEHEUER

GESANG DER JÜNGLINGE is an emblematic composition, both for its composer and for electronic music. In spite of certain bitter opposition due to the use of a child's voice, at the time of its premiere this work gave the feeling that the phase of etudes was over: we are faced here with an opus, in the most emphatic sense of the term. In the context of European work of the fifties, it played the role of a real turning point in musical thought, on the one hand precipitating certain beginnings of a broadening and reassessment of serial thought as it had been formulated in the first half of the decade, and on the other hand making this same thought permeable to some new influences or interpretations. Its antecedents date back to some instrumental works conceived only in anticipation of new technical means; later on, certain strategies implemented here will lead to *Kontakte* and the concept of "Momentform."

In the autumn of 1951, Pierre Schaeffer opened the doors of his studio for *musique concrète* to a younger generation of composers, in order to carry out a first consciousness-raising training course. The works most resolutely turned toward the serial universe were the two *Études concrètes* produced by Boulez, at the end of 1951 and at the beginning of 1952, respectively. Their bases are significantly different from those of the *Konkrete Etüde* that Stockhausen undertook in December 1952. Boulez abides by the natural facts of the materials used (duration and dynamic curve, both functions of resonance) and applies to them a quantified system of the serial type, whereas what Stockhausen is seeking, as early as the first phase of work, is to constitute a malleable material which can, without restrictions, undergo a whole series of transformations—and this independently of its starting nature. This is the real beginning of work on pure sound, this amorphous “atom” of timbre, which it would be possible to order according to the same principles of global serial organization. And the sense of projection is all-important: it is really a question of carrying the general, aesthetic, and technical principles right into the sound. In his first theoretical writing, “Situation des Handwerks” (1952), which remained unpublished at the time, Stockhausen summarized his then-current concerns in the formulation: “There is the consequence that for a work *X* alone, tones exist which bear the ordering character *X* and only as such and alone in this work have their meaning.”¹ The first legitimate realization in this direction, although still posing some problems,² is *Studie I*, which Stockhausen realized in the electronic music studio of the Nordwestdeutscher Rundfunk in Cologne from July to November 1953. In *Studie II*, an expression of a new fundamental questioning, the fusion of the partials is improved, certainly, but the sonorities are also noisier than the crystalline constellations of *Studie I*. These studies made it clear that too simple an acoustic premise had been started from: the conception of new timbres as stable entities. However, with the conclusion of *Studie II*, Stockhausen writes that “the majority of the sound phenomena that we know are ‘nonstationary,’”³ and that such things as the attack, the decay, and the minimal duration necessary to identify a sound intervene in the perception of timbres of phenomena. He infers nothing less than a new definition of the series, as a “series of ‘general factors of modification’ . . . applicable, according to its internal functional definitions, each time to another sound aspect or several sound aspects at the same time.”⁴ From repeated hearing of *Studie II*, Stockhausen extracts new criteria of composition, which he will call “statistical” and which he will present to the public through his analysis of *Jeux* by Debussy.⁵ He focuses his attention on the overall

directional tendencies of movement: the change from one state to another, with or without returning motion, as opposed to a fixed state. These motions can be descending or ascending in relation to some scale or other (on the level of pitches: from low to high; in dynamics: from weak to strong; in tempo: from slow to rapid; etc.). There results a system comprising, if one sets aside the forms created by the superposition of several curves, five situations:

1. \ 2. / 3. ∨ 4. ∧ 5. ∴ ∴ ∴ ∴

For his new electronic music project, Stockhausen derived the shapes of articulation for sound complexes in time from the articulation of a sound, in phases of attack, sustain, and decay. In a work from that time, Fritz Winckel describes these different stages in the following way: the attack is "the setting into acoustic oscillation" of the phenomenon; in the sustain phase, "the various partials react to each other and modify qualities of the sound at every moment"; finally, during the decay, "the timbre is destroyed gradually and is reduced to some elements which fade away."⁶ Whereas the middle part requires more specific means of description and characterization, the extreme parts can in all cases be subjected to the same restricted whole of directionalities to produce a limited number of temporal forms: setting into oscillation and decay from high to low (1), from low to high (2), these two forms combined (3), or setting into oscillation from low to high and decay from high to low (4).

1.  2.  3.  4. 

In the choosing of musical materials, the first stage concerns the acoustic matter to be integrated within a network of relations which gives them direction. Reversing the attitude which had prevailed in his studies, from now on Stockhausen sets out from the acoustical characteristics of the fundamental material itself, which he projects onto the form.

The sine tone and white noise are diametrically opposed in their spectral constitution: the sine tone provides a single precise pitch; white noise, a statistical mixture of all the sounds contained in a given frequency band. However, on the level of their duration these two materials function in an identical way, since neither the one nor the other is subjected to a specific dynamic curve. The impulse is, in terms of its spectrum, between the sine tone and white noise, but has, like percussive sounds, a natural decay. One can thus arrange these materials in a

triangle, the third point being located between the first two and at the same time on another level. As for the human voice, it is placed in the third dimension, as the fourth corner of a tetrahedron, because it includes specific cases of all the acoustic characteristics mentioned above: vowels are like harmonic unfoldings, setting out from sine tones; the fricatives and sibilants are like filtered noises; and the plosives are like impulses with variable intensity and attack.

From each of these materials, Stockhausen derives a certain number of criteria which are then generalized to the other levels of composition: to the other sound dimensions or to the parameters of formal articulation. For vowels, by transference from the realm of pitch to that of durations (rhythm, pitch, and timbre merely constituting the qualitative realms which perception distinguishes within a physical continuum), Stockhausen passes from "spectra to rhythmic formants," as he calls them in his account relating to the techniques of composition implemented in *Gruppen*.⁷ Noise, considered quite generally as chaotic matter, introduces the elements of statistics, of approximation, and of global qualification (as opposed to control down to the smallest detail). As for the impulse, in the systematic relation between sound and silence of the particular orderings, it prefigures in particular the alternation of families of different textures.

* * *

Whereas in "Aktuelles," a reflective article presenting the project as it existed in the spring of 1955,⁸ the number 6 is said to be at the base of all the serial determinations, Stockhausen deviates as far back as the first realization sketches, dating from June 1955. The basic series of the work has seven elements, and is deployed according to the principle of a function of functions developed by Boulez, meaning the transposition of the series onto its own elements.⁹ The basic series and its transpositions constitute the top lines of serial squares of 7×7 elements, the vertical derivation of which is made by the unfolding of cycles of selection with increasing intervals (recall the principle of variable width for sonorities of *Studie II*): in the first square this interval is nonexistent, and so the series is repeated on each line; in the second square, the interval is 1, and the basic series is presented vertically in various rotations; in the third square, the interval is 2, i.e., the new order of succession applied to each element of the transposition makes a value selection on two in the original; and so on

Read horizontally, according to which direction each sound dimension is varied, this systematic transformation of the vertical forms leads to a

constant redistribution of the elements of the series, modifying as much as possible the intervals from one serial form to another. The nonrepetition of contour of the serial forms is the aesthetic principle of "statistical permutation,"¹⁰ which justifies the distribution of the organizing numbers in *Gesang der Jünglinge*. Example 1, a combination from various sketches, contains the complete serial grid, the grid of the durations of reference as well as the scale of variation for each dimension. There are four temporal parameters in the work:

1. the *value*: the fundamental duration which regulates the intervals of entry between successive complexes;
2. the *duration*: the actual duration of each complex obtained by a positive or negative transformation of the value; depending on the duration/value ratio, the complexes will be partially superimposed or will be separated by a silence;
3. the *group of formants*: the number of "octaves of durations" within which the durations will be taken for carrying out the various harmonic subdivisions of the duration, the octave grouping being limited to five octaves;
4. the *evolutionary form in time* where the concepts of attack and decay of the sound, developed above, take place.

The temporal reference grid has seven octaves with seven equidistant subdivisions, and extends from 4 to 512 centimeters, which—for a tape playing speed of 76.2 cm/sec—corresponds to a scale extending from a twentieth of a second to nearly seven seconds.

To realize the first six complexes, constituting a first element of the work, Stockhausen genuinely carves the blocks of rhythmic spectra according to the characteristic forms obtained by application of the serial system.

a. On the level of the *value/duration ratios*, we have:

I	420 : 490	+ 1/6
II	282.6 : 518.1	+ 5/6
III	256 : 213.4	- 1/6
IV	156 : 260	+ 4/6
V	172.3 : 258.4	+ 3/6
VI	116 : 116	unmodified

value	3716524	7453261	1564372	6342157	5231746	2675413	4127635
duration	3716524	1327456	5427163	4617235	7154263	6741532	2753146
formants	3716524	6741325	4736521	1425763	2476135	7453126	5364721
time	3716524	5136742	7612435	2173546	1623457	4512367	6412357
pitch	3716524	2675134	6253714	7256314	4315672	5136274	1275463
dynamic	3716524	4512673	2341657	5734621	6547321	1327645	7536214
timbre	3716524	3264517	3175246	3561472	3762514	3264751	3641572

VALUE	4						
	8	7.25	6.6	5.95	5.4	4.9	4.4
	16	14.5	13.1	11.9	10.8	9.7	8.8
	32	29	26.3	23.8	21.5	19.5	17.7
	64	58	52.5	47.6	43.1	39	35.3
	128	116	105	95.1	86.2	78	70.7
	256	231.9	210	190.2	172.3	156	141.3
	512	463.7	420	380.4	344.6	312.1	282.6

DURATION (1) -1/6 (2) 0 (3) +1/6 (4) +2/6 (5) +3/6 (6) +4/6 (7) +5/6








GROUP OF FORMANTS







number	(1) 1	(2) 2	(3) 3	(4) 4	(5) 5	(6) 1	(7) 2
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


from among the following possibilities:



1	12	123	1234
2	13	124	1235
3	14	125	1245
4	15	134	1345
5	23	135	2345
	24	145	
	25	234	
	34	235	
	35	245	
	45	345	

EVOLUTIONARY FORMS

TIME (1)  (2)  (3)  (4)  (5)  (6)  (7) 

PITCH (1)  (2)  (3)  (4)  (5)  (6)  (7) fixed register

DYNAMIC (1)  (2)  (3)  (4)  (5)  (6)  (7) fixed intensity

TIMBRE (1) R-S (2) S-R (3) RSR (4) SRS (5)  (6)  (7) uniform

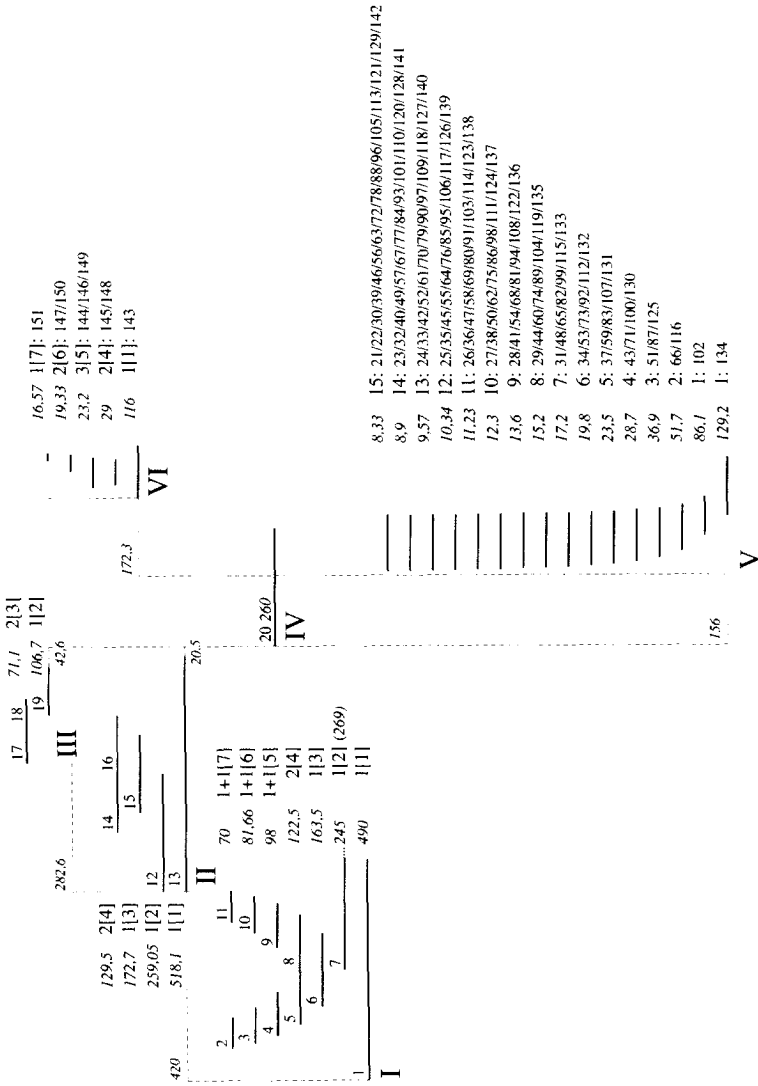
EXAMPLE 1: SERIAL DATA FOR THE BEGINNING OF PART F (COMBINED FROM SKETCHES 1/1-5 AND 57)

b. The *groups of formants*, where the limits for the various octaves of duration are 4/8/16/32/64/128/256/512 cm (durations exceeding this plan not being counted), giving the following vertical articulation:

- I group 3: 490/245–163.5/122.5–98–81.66–70;
ratios: 1:2:4
- II group 7 = 2: 518.1/259.05/172.7–129.5;
ratios: (1):1:2
- III group 1; selection: octave 2
[213.4]/106.7–71.1;
ratios: [1]:2
- IV group 6 = 1; selection: octave 1—the only component sound in
the entire duration of the complex
- V group 5: 129.2/86.1/51.7–36.9/28.7–23.5–
19.8–17.2/15.2–13.6–12.3–11.23–10.34–9.57–
8.9–8.33;
ratios: 1:1:2:4:8¹¹
- VI group 2; selection: octaves 1 and 3
116/29–23.2–19.33–16.57;
ratios: 1:4

(We note that what Stockhausen calls “rhythmic formant” here is a relatively faithful adaptation of the formant notion from acoustics, consisting in more or less dense frequency *regions* which give each sound its specificity. In the instrumental works composed on the same bases, the final part of *Zeitmaße* and *Gruppen*—as well as in the theory related to it, formulated in the article “. . . wie die Zeit vergeht . . .”¹²—“formant” is made the equivalent of “rhythm harmonic,” meaning therefore a simple periodic subdivision of the fundamental duration. The vertical proportional grouping in bands with a width of one octave each, characteristic of the first complexes composed for *Gesang der Jünglinge*, is therefore later replaced by an individual serial treatment of each rhythm harmonic.)

c. By the application of *evolutionary forms in time*, we obtain Example 2. Spectra I and II should make comprehensible the difference between two spectra with settings into vibration from high to low and symmetrical decay, the first hollow, the second solid. However, because of its group of formants, spectrum II does not have enough elements to render this difference perceptible. The evolutionary forms of spectra III, V, and VI are



simple, either a setting into vibration from high to low (III and V), or a decay from low to high (VI). The appearance of the end of spectrum V expresses the difference between "pointed" spectra and those which are denser at the end (III and VI). With only one component, complex IV obviously cannot describe any evolution.

d. For the *pitches*, as formulated in "Aktuelles," Stockhausen works with various scales, at this stage of the project still all dodecaphonic. Their subdivision can be harmonic, subharmonic, or chromatic (equal-tempered), or even result from the mixture of several of these scales. The scale worked out for the realization of the first complexes combines harmonic (*h*) and subharmonic (*sh*) degrees; it is cited here according to the first state of the sketch; by the time of realization, these figures had been rounded: 100, 104.35 (*sh*), 108.33 (*h*), 116.66 (*h*), 127.05 (*sh*), 133.33 (*sh*), 141.66 (*h*), 150 (*sh*), 158.33 (*h*), 171.4 (*sh*), 183.33 (*h*), 191.66 (*h*), 200.

The series used for the distribution of pitches contains, in fan shape, all the intervals: 12-1-11-2-10-3-9-4-8-5-7-6. For the later orders of succession, it is divided into three segments of five (*a*), one (*b*), and six (*c*) elements, respectively, then permuted. With each new line, the preceding result is presented in the form: *c* retrograde, *a* retrograde, *b*, which amounts to isolating the seventh element of each form and then placing it at the end of the retrograde of the preceding form. After twelve permutations, we have returned to the starting point.

The range uses the seven available octaves (numbered from low to high—the first two sounds presenting these limits precisely) and the orientation of the figures follows the envisaged global determinations. Here, by way of example, is the movement of pitches in complexes I and VI:

Complex I: crossing of (*a*) a downward segment and (*b*) an ascending segment possessing a small final relapse

<i>a.</i>			<i>b.</i>		
	<i>octave</i>	<i>sound</i>		<i>octave</i>	<i>sound</i>
1:	7	12	2:	1	1
3:	6	11	4:	2	2
6:	5	3	5:	3	10
7:	4	9	7:	4	9
8:	4	4	9:	6	8
10:	3	5	11:	5	7

Complex VI: ascending movement in two stages (double wave)

	<i>octave</i>	<i>sound</i>
143:	3	5
144:	3	8
145:	4	4
146:	4	9
147:	5	10
148:	5	2
149:	4	11
150:	6	1
151:	6	12

The evolutionary form of the pitches for complex V is limited to the middle octaves for the beginning and the end, and spreads out to the full range at its center.¹³ Now, this motion corresponds to the serial determination planned for complex IV, whereas complex V should have described a simple departure-and-return: descending-ascending. However, since complex IV, with its single component, cannot describe an evolutionary form, Stockhausen transfers its determination (the most complex among the forms selected) to the complex which has the greatest number of particles (V). Thus, he will not be missing an extreme in his grid, which he considers important to present in the most exhaustive possible way from the very beginning. Moreover, this modification breaks up the parallelism between the evolutionary forms of the pitches and of the intensities.

e. On the level of *dynamics*, spectra 1 to 6 fluctuate within an ambitus of two octaves, whereas spectra 7 to 15 move about over a range of three octaves of intensities. One can observe more or less marked local symmetries which are produced during the systematic symmetries in the organization of the pitches.

f. As for the *evolutionary forms of timbre*, the elements contained in the fundamental sketch indicate a statistically prevalent state in the mixture at any given moment, the letters *R* and *S* being the abbreviations for *Rauschen* (noise) and *Sinuston* (sine tone), and appearing there only as an indication. For the first six complexes, the distributions of the materials evolve as follows (with *N* = noise; *I* = impulse; *V* = vocal; *S* = sine tone):¹⁴

- | | | | | | |
|----|--|----|--|----|---|
| 1. | $\begin{array}{ccc} I & I & \\ N & V & N \\ & N & N \end{array}$ | 2. | $\begin{array}{ccc} I & & I \\ & V & \\ N & & N \end{array}$ | 3. | $\begin{array}{ccc} N & S & V \\ & & I \end{array}$ |
| 4. | $\begin{array}{ccc} V & & \end{array}$ | 5. | $\begin{array}{ccc} S & & S \\ & I & N & I \\ V & & V \end{array}$ | 6. | $\begin{array}{ccc} V & S & I \\ & & N \end{array}$ |

For reasons similar to those raised above which had led to changing the form of pitch movement, complexes II and IV exchanged their determinations for timbres. The observation raises an additional discrepancy, namely that the form with the noisy element in the center is applied to complex V and not IV. It is not enough, however, simply to see an extra permutation there, because the interferences between the determinations, which have been isolated up to now, can have consequences in regard to which the composer must take a stand. In order not to distort the sung elements (the permutations of the letters to constitute syllables free from any semantic value were sung as such, and do not result from a sound-editing operation), they can be placed only at the respective ends of complex V, which restricts their pitches to the two middle octaves, a tessitura where it is precisely the vocal element that prevails. Stockhausen realizes concretely, within only one sound complex, the fundamental thought which underlies the whole of this composition, namely the transition from simple phenomena (sine tones and voice) via impulses to noise—here with a return to the starting situation.

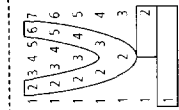
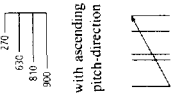
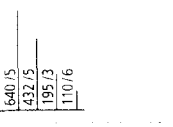
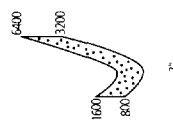
On the level of the text, as this section was intended to be the introduction of the composition, Stockhausen used only the very first line of the Song of the Youths in the Burning Fiery Furnace, the apocrypha of the third chapter of the Book of Daniel, a generic phrase of praise of divine works which will be enumerated subsequently in the canticle.¹⁵ In a second section, also based on temporal spectra but reducing the utilized material to sine tones and a few syllables, the second element of the initial clause is subjected to permutations controlled by a construction on the level of the vocal timbres (the position of the vowels *a* and *i* in the phrase). From the initial clause, which is completely intelligible, one evolves toward another significant phrase while passing through entirely artificial intermediate stages. The complete vocal material of the work is presented in the Appendix where, for this passage, one may refer to part F, sections D4 and H8.

* * *

On 6 August 1955, Stockhausen wrote to Pousseur, having finished twenty-five seconds of his new electronic work. The following day, he left Cologne for Paspels in Switzerland, where he withdrew until the beginning of October in order to start the composition of *Gruppen* and *Zeitmaße*. He also gave thought to how *Gesang der Jünglinge* should be continued. For the reformulated project, he sketched a new beginning consisting of four moments which are written down in a large dramatic curve (parts *A* to *D*). The materials which he plans to realize pursue the route begun at the beginning of the summer, even while introducing new criteria. This differentiation of the criteria is pursued still in part *E*, the whole generating the logic that may be seen here (see Example 3).

The spectra of rhythmic formants, which are the starting point of the composer's thinking, are subjected to a serial generalization by the application of a double variation: in the horizontal direction and the vertical direction.

The horizontal organization of the layers can be periodic, as in the harmonic rhythm spectra, or on the other hand statistical, as in the choral and impulse swarms produced in the autumn. By "statistical," one understands here that the composer has only an overall, qualitative control over the result, but not a quantitative one on the detailed level. And Stockhausen goes so far as to integrate this approximation into the realization regulations themselves. Thus, for the choral swarms, he submitted to the young singer approximate graphs of pitch movement in a given time, where only the number of syllables per layer and the number of layers per complex were determined.¹⁶ However, at the time of the realization it appeared that the young singer could not execute the graphic models with a precision to the nearest centimeter in regard to the overall duration of each layer, and Stockhausen decided to prefer approximate but lively results to a meticulous editing job which would break the phrasing. For this reason one hears in the work some complexes whose beginnings and/or ends give the impression of a setting into vibration or of a progressive decay, which extends certain of Stockhausen's initial ideas and are thus integrated perfectly into the system. As for the impulse swarms, they result from the superposition either of various realizations of the same overall process with a statistical description (the results having a movement of definite pitches in parts *A*, *B*, and *D*), or of different processes carried out within the same temporal limit (nondirectional results in *C*). The parameters of variation, dependent on the machine used (*Abstimbarer Anzeigeverstärker* of the firm UBM), are: pitch, regulated through a filter device, the speed of impulse, and approximate duration of the impulses, regulated via the level of resonance.¹⁷

acoustical references	SOUND sine-tone vowels	SERIAL ORGANIZATION			NOISE	
		PERIODIC	SERIAL	ORGANIZATION	consonants / filtered noise	white noise
layers' intern. articulation vertical organization complex forms	periodic					
	spectra		spectra / formants subdivision of a unit	multiplication of a smallest unit	density	density
	F (D4/H8)		C form	E form	E vocal polyphony	A/B/D choral swarms
	harmonic time-spectra with timbre changes	proportional number of events 1:2:3:4	odd-numbered spectra regular selection	proportional lengths of layers (irregular progression) + permutations	E groups of deep sounds layers regulated through forms of synchronization	A/B/D and C impulse swarms approximative behavior following specific evolutionary forms
examples		28 movements of impulses	11 low filtered impulses			
		21 syllables (3 groups)	9 groups of deep sounds	with ascending pitch-direction	beginning of insert 2	beginning of part A
spatial distribution	Sim 1	7 impulse swarms	5 filtered noises	1 3/1	B3	Cs 3
		1 2 3 4 inserts	3 reverberated deep sounds	permuted to	layer / speaker	layer / speaker
			1 low noise		beginning of insert 2	beginning of part A
					layer / speaker	layer / speaker
					Is 1	Is 1
					beginning of part A	beginning of part A
					layer / speaker	layer / speaker
					layer / speaker	layer / speaker

EXAMPLE 3: TABLE OF MATERIALS

Between these two extremes of periodic articulation and statistical articulation extends the field in which the horizontal dimension is governed by the serial organization: the elements which make up a layer are, in general, whole-number multiples of a unit value in permuted order, the level of periodicity being a function of the vertical.

- The global form of part *C* (*C* form) is made up of four layers of 7, 14, 21, and 28 elements, with the layers in a ratio of 1:2:3:4.
- For the global form of part *E* (*E* form), Stockhausen carried out a regular selection of formants: 1, 3, 5, 7, 9, 11 (spectrum with odd formants).
- For the eleven stratified complexes of deep impulse groups in part *E* (*E* deep impulses), each layer is a mechanical transposition of a loop of impulses at irregular intervals; the lengths of the layers which make up a group are all multiples in irregular progression of a unit value (in Example 3, all the durations, expressed in centimeters of tape, are multiples of 90). Each layer, realized in its prescribed duration and provided with a direction for the frequencies (in the example, ascending), is then broken up into proportional sections for permutation. The temporal shape of the spectra depends on a preestablished catalogue of forms of synchronization, consisting in synchronization of the layers at the beginning and/or the end of the complex, or following a central axis.
- For the vocal polyphonies inserted in the electronic texture of *E* (*E* vocal polyphony), the serial determinations deliver up a grid of variable durations and an index of polyphonic density for each duration, specifying the number of vocal parts which simultaneously articulate a syllable. Moreover, the distribution over the polyphonic voices takes into account the number of resultant syllables per voice; for each vocal insert, there is a different extract from the scale of integers (4 to 6; 4 to 8; 6 to 9 + 5 to 8; 7 and 8), reflecting the idea of the acoustic formant characterizing the sonorities.
- The groups of deep sounds presented melodically in part *C* are joined together polyphonically in *E* (*E* groups of deep sounds) according to an index of density and a form of synchronization describing the profile of the movement of density (in Example 3, a maximum density at the beginning; the figures indicate the duration of each layer in centimeters, and the number of deep sounds by layer).

* * *

The implications of the changes of perspective are felt especially on the level of the working out of timbres, the other dimensions being less immediately dependent on the means of production specific to the period. Independent of obvious implications that will be noted, the aesthetic and technical bases are largely maintained, even if the visionary Utopia gives way to a certain pragmatism, which leads the composer to imagine translating processes of a kind even more proximate to the statistical principle, of permutation from the most elementary level of numerical determinations up to the practical realization of the sound complexes.

Part *A* (0'–1' 01") opens with an impulse swarm which, as it breaks up, gives way to isolated impulses which are controlled on the level of their frequency.¹⁸ Over a background of supporting sounds consisting of combinations of variable electronic timbres, there follows an alternation of isolated words (with a grouping into 2–3–1–4 syllables) and of choral swarms (whose vertical density varies according to serial forms: 6–4–3–7–5–1–2/4–6–3–7–5–2–1/etc.—see the Appendix), until some isolated impulses are accelerated until they become transformed into a new impulse swarm, at the same time a complement to and a counterpart of the first. With the exception of the final gesture, the simple phenomena are concentrated in loudspeaker I, whereas the mass phenomena sound in turn in one or several other loudspeakers. For the evolutionary forms of pitches, only the elementary forms and their simplest combinations (successive directions of movement without intertwinement) were retained. As for the spacing of events, it is subject to a distribution in zones with a duration from 1 to 7 seconds, partially following the basic series. Significantly, parts *A* and *B* each start with a transposition of the original form, whereas the other serial forms utilized have statistical permutations of the elements.

A: 7453261/1653472

B: 6342157/6271435/2765134/1534627


















In addition, the actual durations in centimeters are drawn from the grid of tempered durations; it follows that the indications in seconds are approximate and can even vary for one and the same reference expressed in seconds. Thus, for the theoretical value of 1 second (that is to say 76.2 cm), Stockhausen uses various durations: 86.1, 78, and 70.7 cm.

Whereas in *A* there is an overall opposition of simple and complex phenomena in the two "rich" timbres—voice and impulses—parts *B* and *C* will divide these up between them. In *B* (1' 02"–2' 42"), Stockhausen makes use exclusively of choral and impulse swarms. The double temporal determination consisting of interval of entry and actual duration of

the events opens up silences here and there between the choral swarms which, usually, are partially superimposed. These zones of silence are filled by impulse swarms. The new choral swarms in *B1* no longer exhibit characteristic pitch profiles but are restricted to a fixed frequency band; in *B2* and *B3*, the previously introduced stable and mobile forms interact, either successively, or simultaneously. The three sections of part *B* are distinguished, moreover, on the level of their spatial effect: in *B1*, the dynamics are constant by event; in *B2*, the variations of amplitude give way to a sensation of variable depth; in *B3*, the choral swarms move irregularly around the audience, anticipating the rotation of the long impulse swarm which is at the same time the result of the thickening and compressing of the events in *B2* and *B3* and the beginning of part *C*. A similar phenomenon governs the utilization of the canticle's text. *B1* continues the statement of verses 1 to 3 begun in *A*, whereas in *B2* and *B3* the principle of permutation becomes more widespread, directed at first in the choral swarms drawn only from verse 2 (*B2*), and then upon all of creation which praises the Lord (*B3*—where the generic expression "ihr Werke alle des Herrn" no longer occurs).

The arrangement of the impulse swarms on the grid of intervals of entry shows how Stockhausen adapted his ideas concerning evolutionary forms to this new context (Example 4). An exception occurs in the second impulse swarm in *A* (which is necessary to mark the symmetrical articulation of this part on the level of the form of the timbres: a very large form, of impulse-noise-impulse, on which is superimposed the double layer of vocal elements), the durations of the swarms in seconds are varied according to a series of seven elements, whereas the forms of pitch movement describe the different possible forms, with a double interpretation of the "fixed register," i.e., of the model of variation number 7. Over the whole of parts *A* and *B*, the evolutionary form for the timbres of these complexes is: impulses/impulses intercut with complexes of sine tones/impulses—that is, a symmetrical form once again. And in spite of its simplification, the parameter of timbre retains all its revelatory power: among the complexes with two timbres, only the two materializations of the model of variation 7 make exception regarding the principle of an impulse swarm broken off by an artificial resonance.

Part *C* (2' 43"—5' 12"—graphic transcription in Example 5)¹⁹ exhibits the full extent of the world of impulse variation. In order to distinguish the three types of sections which alternate irregularly, two statistical variants of impulses (IN1 and IN2) appear alongside regular melodic successions (IK). IK stands for *Impulse künstlich*, i.e., isolated impulses stuck onto leader tape according to a serial grid of spacings; IN stands for *Impulse natürlich*, i.e., successions of impulses delivered directly by the

A		B		7 α	7 β	6	1	form	time in seconds	timbre
5	5	2	4	3	7 α	6	1		4	S I
										
										S I
7	(2) 1	1	6	3 (+2)	2	5	4			

EXAMPLE 4: IMPULSE SWARMS IN A AND B (WITH DURATIONS)

The image displays a musical score for Part C, organized into five systems (I to V) and multiple staves. The notation is highly abstract, featuring various symbols, lines, and text labels. The labels include 'Herrn', 'und', 'des Himmels', 'preiset den Herrn', 'Re-', 'ler', 'al-', 'Sonne', 'Mond', 'Preist', 'den', 'gen', 'tau', 'Herrn', 'preist', 'den', 'de', 'ihr', 'Win-', 'IK', 'IN1', 'IN2', 'I', 'V', 'II', 'III', 'IV', 'V'. The score is presented in a grid-like format with five main columns corresponding to the systems and multiple rows of staves. The notation includes various musical symbols such as notes, rests, and dynamic markings, along with text labels that appear to be lyrics or performance instructions. The overall layout is complex and detailed, typical of a musical score for a new music composition.

EXAMPLE 5: PART C, SCORE

generator. Despite the fact that these abbreviations date back to a first intention for realization, and Stockhausen changed the mode of production of the IKs (generating them directly with the machine, as well), the different sections reflect well the initially selected characterizations, which can therefore always serve the needs of analysis as well as those of hearing. An additional mode of orientation between these two large families is the movement of the sounds in space, because the periodic and statistical phenomena rotate in opposite directions. The beginning of each section is announced by a short but dense impulse swarm, to which choral swarms are assimilated three times. The voice intervenes, always with distinct syllables, in the sections with only isolated impulses, thereby showing analogous melodic-treatment criteria for the two phenomena of different material origin.

On the level of serial organization, several factors interact. To begin with, the number of events per timbre. The principle of the harmonic formant is transferred into the realm of form (with the number 7 as basic unit)—see Example 3. This numerical data was slightly altered: for instance, there are twenty-two vocal entities, some of which do not consist of isolated syllables but of groups of syllables of variable density (4, 3, 2); and the reckoning of impulse swarms includes neither the big initial swarm, nor the last, at the beginning of the background layer of part *D*, both with the profile of frequencies polished over the course of time.

The durations of the sections and the spacing of the vocal sounds, or of groups of deep sounds, draw their values from the tempered grid of seven elements by the application of a cycle of selection with interval 5.²⁰ Such a mode of selection of value within the grid reproduces in a completely different context the principle of derivation by a variable cycle from the initial serial table. What is remarkable for this cycle of interval 5, is that the values selected are in ratios surprisingly close to those of one of the Fibonacci series, the sum of two consecutive elements always approximating the following element closely enough.

The durations for the fragments making up the impulse swarm which opens part *C* are taken from the tempered grid but, this time, according to a cycle of interval 3: 5.4, 7.25, 9.7, and so on, up to 190.2.

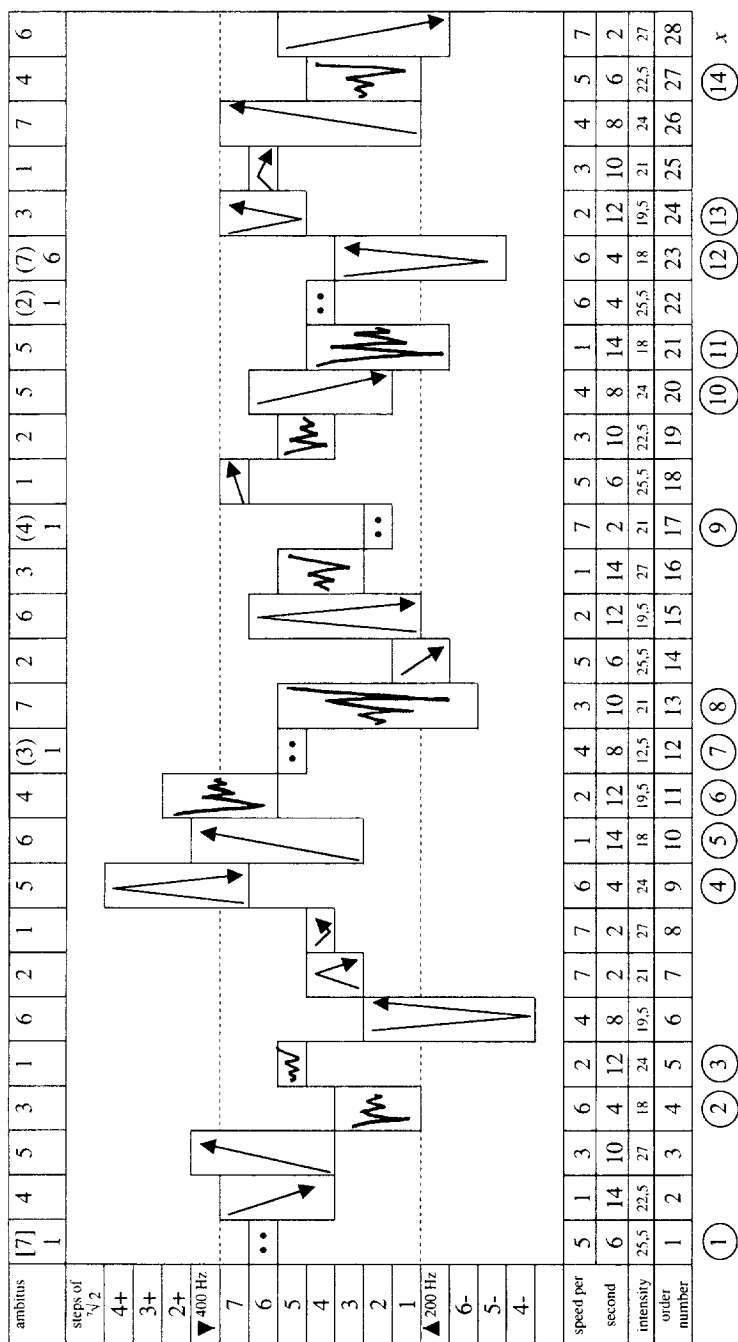
The sections, in addition, will be subdivided in order to control the organization of the background elements: bands of filtered noise and groups of impulses, distinct or statistical. To this end, Stockhausen extends the principle adopted for parts *A* and *B*, i.e., the durations of reference expressed in seconds. As such, they apply to the sections with distinct impulses; for the sections with statistical impulses, they will alternate with values taken from an original scale of “dotted” values: 110 (78 +

32), 258 (172 + 86), 326 (210 + 116), 439 (283 + 156), 570 (380 + 190), 696 (464 + 232), 795 (512 + 283) cm.²¹

A set-up governed by the number 7, which is the foundation of the first serial data of *Gesang der Jünglinge*, is effective on several levels in the working out of figures with distinct impulses. The various parameters are: the evolutionary form of pitches, the ambitus (the base of which, theoretically, is the subdivision of the octave into seven equidistant steps), the number of impulses per second which the machine delivers (even-numbered settings only), and intensity. On the level of ambitus, the transfer into the pitch realm of the principle previously tied to the organization of durations demonstrates in a way such that it actually could not make more plain the equality between the dimensions in the serial universe, an equality which is the very basis of the concept of "parameter," which is used by Stockhausen precisely from the moment where the determinations exceed the framework of the acoustic dimensions of the sound phenomena.²² Example 6 shows these data as they appear in the work, taking into account the various modifications which occurred while working them out, up to the final realization; it contains, moreover, the indications of grouping of the twenty-eight figures in fourteen sequences (one of density 2, two of density 4, three of density 3, and eight of density 1—another allusion to Fibonacci: 1-2-3-[5]-8).²³

In part *D* (5' 13"-6' 20"), tracks III to V from the middle section of part *B* are heard in reverse. Onto this mixture of choral swarms (immediately identifiable as being of vocal origin though the text is not comprehensible) and impulse swarms are grafted vocal chords of variable density in a homorhythmic setting. The spacing of the vocal chords, whose density varies syllable by syllable according to the serial forms 2-6-5-3-7-4-1/5-3-6-4-2-1-7, is calculated on the basis of a cycle of interval 5, transposed in respect to the grid of reference according to the length of the segment, taken again from part *B*. The end of *D* marks a reduction of the voice to its simplest means, isolated syllables more declaimed than sung, accompanied by very fine impulse sizzlings in the high register to begin with, and then alone.

Part *E* is built from a scale of electronic timbres developed from those of part *C*. On the level of form, electronic and polyphonic-choral sections alternate antiphonally, interrupting the continuous course of the electronic part, which is organized over the whole of *E*'s duration according to a spectrum with odd formants—see Examples 3 and 7. Each layer is divided into groups of variable density, multiples of a different basic unit. In addition, the two most complex layers—the groups of impulses and of deep sounds—vary with each of their appearances in density and on the level of their form of synchronization.



EXAMPLE 6: FIGURES OF DISTINCT IMPULSES IN C

The collection of groups of deep impulses is based on a single tape loop 540 cm in length, on which the impulses are spaced according to a serial distribution (128-60.4-36.5-13.3-22-77-10.3-100-17.1-47-28.4 cm, i.e., a permuted order in the scale according to the series: 11-8-6-2-4-9-1-10-3-7-5). The proportions which regulate this smallest-scale spacing also serve to determine spacings of the various groups. The values of durations are chosen again by means of a cycle of selection, this time with interval 4. But instead of resorting to the grid of the durations used up to now, Stockhausen turns to a scale of eleven degrees per octave, which was used in *C* to determine the pitches of the vocal interventions. This loop of impulses is then transposed (brought to a duration of 900 cm in the example in Example 3) and provided with a pitch direction, then divided into proportional parts in permutation, and finally synchronized at the rate of one layer per loudspeaker. The relationships between the lengths of the various layers are also proportional, but the progressions are not regular, as is also the case for the spectrum of odd formants organizing the distribution of timbres.

reference length: 7020cm

subdivision/
unit serial repartition of the subdivisions
 in proportional distribution

:78/90	14 6 10 8 3 12 2 9 5 7 11
:55/128	2 6 9 5 3 10 7 14 8
:36/195	12 5 3 4 6 8 7
:21/334	4 6 5 2 3 1
:10/702	3 2 4 1
:3/2300	2 1
number of speakers	2 3 1

EXAMPLE 7: FORMAL SKETCH OF PART *E* WITH INDICATIONS OF THE OVERALL DURATIONS AND OF THE SUBDIVISIONS FOR EACH LAYER

The groups of deep sounds are constructed on the basis of groups introduced in *C*, with the possibility of being transposed before being integrated in the new entity. The fifth one presents a special feature because it is, according to Stockhausen's expression, "rhythmicized," i.e., the parts of sound and silence alternate, for a total duration of 540 cm for the sounding parts and 740 cm for silences. 540 cm is the length of the loop of deep impulses, and the isolated durations in the mixing of deep sounds vary according to the subdivisions of this loop. The scale with the overall value of 740 cm is taken from the same scale of eleven degrees per octave and according to the same interval of selection. These two numbers also govern the vocal polyphonies which last 990, 740, 1280, and 540 cm, respectively ($1280 = 540 + 740$; the 990 cm are divided according to the same durations as the eleventh group of impulses, which is of the same length and which had been produced by transposition of the initial loop in the ratio 50:27.3).

The filtered impulses in the high register attest to a strict organization on the level of the group (2-1-3-4/1-4-2-3)—there are eight groups in all, because part *E* starts with high impulses, a timbre common to parts *D* and *E* which serves them as a pivot. Durations and transpositions of the filtered fragments change independently; for the first, Stockhausen returns to the grid of seven equidistant degrees from which he takes, in a cycle of interval 4, a total number of seven values: 11.9-17.7-26.3-39-58-86-128, which appears in the order $x-3/7/1-6-5/2-4-6-7/5/4-1-3-2/6-5/4-7-3$, reproducing first the basic series and a transposition in rotation: 3-7-1-6-5-2-4 and 2-6-7-5-4-1-3 starting from the 6.²⁴

The vocal polyphonies inserted into this electronic texture have a different number of voices each (3-5-4-2), clearly perceptible because each voice sounds from a different loudspeaker (for the insert with maximum density, Stockhausen has, in addition, superimposed two voices per loudspeaker). The serial organization extends to the number of attacks per layer and their variable vertical density (see Example 3);²⁵ the durations for the syllables were selected from the scale of eleven degrees per octave by means of a cycle of interval 4. Precision in the realization of the durations is made possible by the fact that the young singer stresses the consonant aspect of the words here: *Eis*, *und*, *Herrn*, *preist*, *Frost*. The spectral nature of consonants in fact allows an *a posteriori* assembly more easily than for vowels, which are more sensitive to dephasing. As these polyphonies were to be assembled sound by sound, the intonation could be refined and very precisely controlled. The scale comprises sixty equidistant degrees per octave and is, in each insert (*i*), traversed according to a different cycle of selection (*cs*):²⁶ *i1-cs2*; *i2-cs4*; *i3-cs3*; *i4-cs1*. These frequencies are gathered into sets of five pitches, and then permuted

according to a series of five elements (2-1-4-5-3) deployed accordingly (Example 8).

On the level of number manipulation, Stockhausen returns here, as in the groups of deep sounds of part *C*, to the technique advocated in *Studie I*, that is, to a series deployed in a function of functions whose elements are joined together in aggregates of variable density by an index of grouping. This may be surprising in a work in which, until then, the composer has constantly carried out statistical permutations according to ever-new principles, some of which are systematic whereas others are irreducible to a unique process. Does this diversity of strategies necessarily suffice to explode the unifying serial idea? No, because Stockhausen's concern is detached from the processes themselves in order to focus even more on their results, independently of the path which led there. In the vocal polyphonies, the quantity of data to be managed is relatively important, and a systematic procedure facilitates their organization. In addition, the variable grouping, the durations partly independent of the simultaneously attacked syllables, the spatial distribution of the voices of the polyphony, and the different scales for each insert so effectively thwart the emergence of isomorphisms so that the chosen tool is only seemingly in contradiction with the subjacent thought. The actualization within the piece, which is dependent on intermediate manipulations that really do modify the appearance, prevails over the elementary preparations, chosen for their simplicity and their speed of execution.

The temporal plan which is the basis of the final part, *F*, and which Stockhausen had worked out at the time to produce the first complexes with mixed timbres, follows a long departure-and-return curve between long and short values of duration traversing seven octaves of durations.²⁷ However, the new overall proportions required a longer duration for this sixth part, for which reason Stockhausen grafts onto the returning movement toward longer values two "rhythmic inserts," which occupy only the four highest octaves of the scale of durations. The internal organization of these inserts combines determinations of duration in seconds (from 1 to 6) and of directional tendencies, simple in the first insert, compound in the second. The simple directional tendencies are:

1. values statistically all rapid (higher octave)
2. values statistically all slow (lower octave)
3. accelerando
4. rallentando
5. accelerando-rallentando
6. rallentando-accelerando

scale (subdivision of 60 steps per octave) and selection following a cycle of 4								
634.5	und	a1	503.6	Frost	b1	399.7	Herrn	c1
627.2			497.9			395.11		
620			492.1			390		
612.9			486.5			386		
605.9	und	a2	480.9	Frost	b2	381	Herrn	c2
598.9			475.4			377.3		
592			469.9			372.9		
585.2			464.5			368.6		
578.5	und	a3	459.2	und	b3	364.4	Herrn	c3
571.9			453.9			360.2		
565.3			448.7			356		
558.8			443.5			352		
552.4	Eis	a4	438.4	den	b4	347.9	Herrn	c4
546			433.4			343.96		
539.7			428.4			340		
533.6			423.5			336.1		
527.5	Eis	a5	418.6	Frost	b5	332.2	Herrn	c5
521.4			413.8					
515.4			409.04					
509.5			404.35					
series for ordering			21453					
			15342					
			43125					
a			54231					
b			32514					
c			15342					
			54231					
			32514					
			43125					
			21453					
density series for syllables			Eis (2) und (4) Frost (3) den (1) Herrn (5)					
order of syllables			Eis (a5 + a4)					
			und (a2 + a3 + a1 + b3)					
			Frost (b2 + b5 + b1)					
			den (b4)					
			Herrn (c1 + c5 + c3 + c4 + c2)					

EXAMPLE 8: FREQUENCIES OF THE SYLLABLES OF THE SECOND VOCAL POLYPHONY (CF. EXAMPLE 3)

The compound variants combine one of the static possibilities (1 or 2) with one of the emphatic movements (3 to 6).

Serially, the order of succession of the durations of sections in the inserts is regulated by the transpositions of a serial form of six elements (4-1-2-6-3-5) obtained by filtering starting from the last transposition of the basic series of seven elements: 4-1-2-(7)-6-3-5, by analogy with the limited ambitus of durations available in these inserts.

4 1 2 6 3 5	
1 4 5 3 6 2	first insert
2 5 6 4 1 3	
6 3 4 2 5 1 + 2	second insert

At the beginning of part *F*, Stockhausen places those first few seconds which had been realized in the summer of 1955. The distinction between value and duration of an event which had prevailed there will be maintained only up to the thirtieth value, the later ones taking concrete form in terms of complexes each having but a single sonority. From here on, the sounds follow one another continuously, sometimes interrupted by silences which constitute an additional means of articulation. The possible superpositions between loudspeakers result from a new criterion, namely a regulation of polyphonic principles by section (in the spirit of the synchronization forms in *Studie II*), the extremes of the scale being strict alternation between the loudspeakers ("Wechsel") and the superposition of a new element onto a resonance in one or more other loudspeakers ("Polyphonie"), the intermediate cases resulting from combinatorial operations on these two strategies ("Kombiniert").

The articulation of the formal plan for this final part (see Example 9) fulfills a principle of polyphony as well, because it superposes two partially independent temporal structures. They have in common their overall durations, each divided according to a different principle (a procedure similar to the independent movements of tempo in *Zeitmaße*). The framework is provided by a series expressed in seconds (54-36-45-27-9-18), in which the internal articulation is made up, in the first structure, of multiples of the unit of 3" (initially according to the same series 6-4-5-3-1-2, and then according to permutations which allow the lower level to adopt the proportions from the higher-level framework) and, in the second structure, according to a division of the overall duration into four proportional sections. Each global duration is brought out, on the one hand by a particular polyphonic type, and on the other by a prevalent loudspeaker in the spatial set-up. The first structure combines the

section duration in sec.	1st rhythmic insert				2nd rhythmic insert			
	54	36	45	27	9	18		
field duration in sec.	18	12 15 9	3 15 9	6 9 15	3 6 12	3 6 18		
polyphonic type	Wechsel	Polyphonic	Kombiniert	Polyphonic	Polyphonic	Kombin.		
group (number of sounds per unit)	1	2 4 6 5 3	6 3 1	2 3	2 5	4 1		
number of octaves	6	4 5 3	1 5 4	2 3	5 4	1 2		(6) 5/1 (synchr. 2/4)
scales (subdivision per octave)	7	13 10 16 12 11	17 9 11	15 13	8 9	22 19		6 7
prevalent speaker	1	4	2		5	3		1
duration for speaker changing in sec.	21.6	10.8 5.4 16.2	3.6 14.4	10.8 7.2 18	2.7 5.4 10.8	49.27 5.4 3.6 1.8		
number of speakers	5	3 2 4	3 4 2	5	4 5 5 3	1.8 3.6 7.2		
selection of speakers	1 2 3 4 5	14 5 13 1 2 3 5	42 4 3 2 1	4 1 43 215	54 543 id. 531	33.3 45.4 21		5 1 2 3 4 5
grouping form	IV	III I II	IV III (I)	II (III)	IV— I II	III II		III
timbre field	D 4	H 8 R 6 N 10	V 2 M 11	F 6 B 2	W 1 G 7 K 11 C 3	S 5 E 5		—L12—
0 dB						O 9		

EXAMPLE 9: GENERAL PLAN FOR PART F

determinations relating to grouping (the maximum number of sonorities which can constitute a figure), to the ambitus of the scales (number of octaves), and to their subdivision (all in equidistant steps); the second ties together the number of loudspeakers (and their selection), the combination of timbres in terms of homogeneity or heterogeneity and the selections from the scale of timbres, adding up to twelve different categories (i.e., their grouping form).

For the first set of structures, the direct relation between the ambitus of the scales and the durations of the sequences must be emphasized: this close correspondence between the horizontal and the vertical is the very basis of the temporal organization of *Gruppen*, where the maximum number of rhythm harmonics per group corresponds to its number of fundamental durations. In addition, the subdivisions of the scales used per polyphonic type attest to a taxonomy of distribution which anticipates *Kontakte* on several levels: for "Polyphonie," the scale progresses by steps of 1 (7-8-9-10-11-12); for "Kombiniert," by steps of 2 (7-9-11-13-15-17); for "Wechsel," by steps of 3 (7-10-13-16-19-22). The distribution of pitches does not ensure, however, throughout part *F*, any real function of formal articulation: it is rather used to describe the different scales of variable rates for filling-in by a statistical scanning.

The articulation of the form depends, on the contrary, upon decisions relating to timbre, namely the type of combination within the figures formed by grouping and the portion of the timbral scale exploited in each section. Spatial projection, in addition to its dramaturgical function, also serves the clarification of this double articulation of timbres.

First of all, the four fundamental materials were increased to a catalogue of twelve categories:²⁸

1. sine-tone complexes
2. impulse complexes
3. vocal sounds or syllables
4. white noise filtered to about 2% width (in Hz)
5. single impulses with definite pitch
6. synthetic vowel sounds (spectra rich in overtones with varying formant combinations)
7. white noises filtered to a width of 1 to 6 octaves
8. impulses in swarms of statistically defined density, filtered to a width of 1 to 6 octaves

9. single impulses synchronized in chords
10. chords of narrowly filtered noises
11. sine-tone chords
12. vocal chords

The extremes are the elements with the simplest spectra (sine-tone complexes) and those with the most complex spectra (sung chords). The gradation is, according to Stockhausen, the most continuous possible. Having established this hierarchy, Stockhausen works twenty-three combinatorial possibilities out of it, designated successively from A1 to L12, then from M11 to W1: the index represents the number of timbral categories contained in a field, it being understood that from A to L, a new category is always added to the scale in order of increasing complexity, and from M to W the categories are subtracted one by one until finally only the vocal chords are retained.²⁹ To obtain these fields' order of succession, Stockhausen deploys their representatives vertically in six columns, the first three in correct order, the last three with an interchange of the second and fourth elements or, put another way, in rotated retrograde:

A	E	I	M	Q	U
B	F	J	P	T	(X)
C	G	K	O	S	W
D	H	L	N	R	V

In the composition the fields will appear, interrupted by two long silences, in the order:

D H R N V M F B // J P X // T W C G K S O E L

that is, a free arrangement by line; the exchange of the fields M and L results from a later operation; the fields not used were not related to the draft of the formal plan.

For the combination of timbres, Stockhausen distinguishes the bodies and the endings of the figures, ringing the changes independently between a homogeneous situation and heterogeneous successions of timbres. The four possibilities are:³⁰

	<i>body</i>	<i>endings</i>
I	heterogeneous	homogeneous
II	homogeneous	heterogeneous
III	heterogeneous	heterogeneous
IV	homogeneous	homogeneous

In order that this timbral structure may be really effective as a guide to perception, Stockhausen increases its obviousness by interrupting the course of sonorities on various occasions, entrusting to the silences thus created some revealing functions of various orders. The first silence separates the first thirty values, which are obtained by modification of the fundamental duration, from the remainder of the curve of values, where sonorities follow one another without automatically generated superpositions or interruptions. As the overall determinations for part *F* were distributed over the large form according to durational proportions in centimeters of tape, and not according to key points of group articulations, the overlapping or transitional groups between harmonic fields and polyphonic types are the rule, and not exceptions. The field of timbres which follows this first interruption, N10, includes at its beginning and end the last group of R6 and the first of V2 (the latter does not yet adopt the new scale of timbres but does already have the new form of internal timbral articulation, IV: =, =). N10 is articulated by silences according to a grouping series for the figures (1-5-3-7-6-4-2), which implies, with the first interruption, a total of eight silences, the seven first of which follow the original series 3-7-1-6-5-2-4, in duration classes selected from the grid of reference durations (values: 52.5-70.7-32-39-86,1-58-47.6; elements 1, 5, and 7 are multiplied by 2, the third by 4); the eighth silence again takes a duration of class 7, that is to say the beginning of a serial form on the second term of the series—a logical procedure according to the principle of the function of functions. The following silence lasts nearly eight seconds and includes four non-structural chords of impulses grouped in 1+1+2 attacks: it separates off the large sections of “Polyphonie” from the following ones, which are in “Kombiniert” mode. Fields J10-P8-X1 form the central section of this part. In J10, the silences are colored by choruses in the background (choral swarms from *A* and *B* repeated in a loop) and they separate groups of figures with an identical final timbre, changing group by group. In P8 and X1, the silences are really empty and they isolate the rhythmic insert’s various temporal zones, measured in seconds and each provided with an internal movement of different durations (2-5-6-4-1-3 seconds). X1 is followed by a second long silence, filled in gradually in the fifth loudspeaker by the

syllable “ihn,” reverberated for a long time and played backwards. The last two silences, at the beginnings of O9 and L12 respectively, isolate the short section in “Wechsel” mode before the final section in “Kombiniert” mode, which returns, after the second rhythmic insert, to the long values of the beginning of part *F*. The closing gesture of the work appears like it was cut off from the rest of the final structure because of the elimination of a long vocal chord on “Herrn,” which was to have joined parts *F* and *G*, and which, structurally, belongs already entirely to the unfinished part *G*.

* * *

The two elements put forward by Stockhausen in the general introductory texts to *Gesang der Jünglinge* are the composition of timbres and spatial articulation. The desire to have at his disposal electronic sounds of a complexity comparable to vocal sounds had spurred him towards the composition of sound complexes integrating particles of various material origins. The difficulty and the slowness of realization of such complexes, however, led the composer to imagine, for the interaction of timbres, different transpositions to formal levels by a variety of grades. The majority of the events, taken separately, have a homogeneous timbre and only their combination in the form gives rise to significant distributions. In the most general way, the principles of interaction are summarized by polyphony (parallel control, largely independent of the various layers of events) and by alternation (interruption of one type in favor of another). A typical instance of polyphony clarified by spatial disposition occurs at the beginning of the work, with all the behavioral types of electronic sounds in one and the same loudspeaker; alternation is presented for the first time in part *B* with the impulse swarms which fill in the empty spaces of the vocal structure. In part *C*, these two principles are combined in different respects:










- the continuous weft of groups of deep sounds which constitutes a polyphonic element independent of articulation into sections;
- within the sections with distinct impulses, the unfolding without any reciprocal interference of impulses and syllables;
- the alternation of groups of distinct and statistical impulses, and on a lower level, of presence and absence of the weft of noise and impulses in the sections with distinct impulses, of presence and absence of groups of filtered impulses in the high register in the sections with statistical impulses.

In part *E*, the relation of alternation between vocal elements and electronic material is the opposite of the situation in *B*, because it is the vocal inserts which come to interrupt the electronic weft. What's more, in *E* the most clear-cut juxtaposition coexists with polyphony of the greatest number of independent layers.

The degrees of intelligibility of the text to which Stockhausen drew attention for the beginning of the work³¹ are precisely a function of the degree of structural transparency, of the relative potential for analysis which the listener is offered. From this point of view, the electronic and vocal parts of *E* have a common denominator: each layer being heard in one loudspeaker, the distinction of the components of the polyphony is, if not easy, at least possible. On the other hand, the choral and impulse swarms packed together into compact blocks assigned to only one point in the hall (parts *A* and *B*, especially) make impossible any attempt to distinguish the components. In the sections of part *F* where the bodies as well as the ends of the figures are different, Stockhausen exploits two different strategies. In M11 (see Example 10), where the grouping makes it possible to put together units of a certain length, he takes advantage of the speed of succession of the events delivered by the first rhythmic insert to produce, thanks to a certain fusion of the components, the illusion of timbral transformations within the same complex (a perspective which prolongs the complexes which were the first ones realized and came to be integrated into this final part). In P8, where the grouping of density 1 would normally bring about a complete and utter explosion, it is the spatialization which intervenes to clarify the composition of the timbres by allotting to certain loudspeakers all the variants of one category of timbre and by concentrating the irregular changes in only one loudspeaker.³²

In the more analytical commentary that Stockhausen has devoted to *Gesang der Jünglinge*, "Musik und Sprache III," there occurs a particularly cryptic sentence relating to the fields of timbres in part *F*, whose solution could well contain the cornerstone of the entire edifice: "*x* receives a structure with a particular definition, resulting from the general layout of the work."³³ However, field X1 is comprised exclusively of chords of isolated impulses, a timbre which had just already been added at the end of field B2 in the form of three interventions at the beginning of the first long silence in this part. B2 contains, according to the schema, nothing but complexes of sine tones and complexes of impulses. However, the only complex of sine tones that Stockhausen retains for this passage is complex V from the beginning of *F*, i.e., a mosaic of timbres in which one of the verbal permutations carried out upon the word "jubelt"—the syllable "tuj"—is particularly prominent. Its percussive character to some extent predestined this complex to be associated with

List of timbres for the score excerpts to part F

- | | | |
|-----|---|---|
| 1. |  | sine tone complexes |
| 2. |  | impulse complexes |
| 3. | words | vocal sounds or syllables |
| 4. |  | narrowly filtered noises |
| 5. |  | single impulses |
| 6. |  | synthetic vowel sounds [deep sounds] |
| 7. |  | colored noises filtered according to an ambitus varying from 1 to 6 octaves |
| 8. |  | swarms of impulses filtered according to an ambitus varying from 1 to 6 octaves |
| 9. |  | chords of isolated impulses |
| 10. |  | chords of narrowly filtered noises |
| 11. | | sine tone chords |
| 12. | WORDS | vocal chords |


To differentiate class 2 from 8, and 4 from 7, refer to the vertical placement (at the top of the fields and in their center respectively); the chords are drawn twice as large. The durations of the words/WORDS are indicated by empty boxes (words above, WORDS generally below). R signifies that a sound is reverberated.

EXAMPLE 10A: KEY TO EXAMPLES 10B AND C

[R6 ; form I (≠ , =) sc 10 / 5 oct]


N10 ; form II (= , ≠)

I




II

Reif und Frost




III

preist




IV

HERRN



V

und Eis



EXAMPLE 10B: EXTRACT FROM THE STUDY SCORE: PASSAGE FROM R6 TO N10 (ONE SYSTEM)

[N10] ; form IV (= , =) sc 12 / 1 oct V2

M11 ; form III (≠ , ≠) sc 11 / 2 oct

POLYPHONIE

I



den



R

R

PREI



R

LICHT

II



(cont.)

(cont.)

R

DEN

R

UND

III



(cont.)

(cont.)

R

KEL

IV



SET

HERRN

V



R

DUN

EXAMPLE 10C: EXTRACT FROM THE STUDY SCORE: PASSAGE FROM V2 AND THE BEGINNING OF M11 (TWO SYSTEMS)

4" ↗

1" →

2" →

I	jubelt	sc 7 / 6 oct	STRAH	R
II	R		tuj	R
III	HERRN		ZE	R
			ihr alle	LEN
				und
IV			über alles	R
V			BLI	R

beginning of the first rhythmic insert

EXAMPLE 10c (CONT.)

the impulse structures. The impulses have played a signposting role throughout the composition, and it is the same here: framing function in *A*; filling-in of silences in *B* (and *D*); articulation into sections and individualization of basic texture in *C*; main framework in *E* (the proportions of which govern the other phenomena); emphasized ending of each of the large sections in *F*. In the closing gesture, finally, it is again a complex of impulses which predominates. In the network of serial relations the impulses, which are located metaphorically between the sine tone and noise, assume a function of vital mediation which makes them also equivalent to being agents of the keypoints of the form.

—Translated from the French by Jerome Kohl

APPENDIX

verse	basic text
1a	Preiset (Jubelt) den(m) Herrn, ihr Werke alle des Herrn
1b	lobt ihn und über alles erhebt ihn in Ewigkeit.
2a	Preiset den Herrn, ihr Engel des Herrn
2b	preiset den Herrn, ihr Himmel droben.
3a	Preiset den Herrn, ihr Wasser alle, die über den Himmel sind
3b	preiset den Herrn, ihr Scharen alle des Herrn.
4a	Preiset den Herrn, Sonne und Mond
4b	preiset den Herrn, des Himmels Sterne.
5a	Preiset den Herrn, aller Regen und Tau
5b	preiset den Herrn, alle Winde.
6a	Preiset den Herrn, Feuer und Sommersglut
6b	preiset den Herrn, Kälte und starrer Winter.
7a	Preiset den Herrn, Tau und des Regens Fall
7b	preiset den Herrn, Eis und Frost.
8a	Preiset den Herrn, Reif und Schnee
8b	preiset den Herrn, Nächte und Tage.
9a	Preiset den Herrn, Licht und Dunkel
9b	preiset den Herrn, Blitze und Wolken.

Explanation of symbols

Vocal categories

sy	syllable or monosyllable
vc	(text in capitals) vocal chord, variable in density according to the superscript
cs	choral swarm, variable in density according to the superscript (the alternative versions "Herr(e)n" and "lob(e)t" are not being constantly repeated)
vp	vocal polyphony, variable in density
sm	temporal harmonic spectrum of mixed timbres, numbered
sm'	modified spectrum
sy/sm	syllable in a spectrum of mixed timbres (the underlined syllables are made conspicuous)

unities

- [] staggered: superimposition of successive entries
- [] enclosed in brackets: superimposition of simultaneous entries

nomenclature of sections (with the exception of the subdivisions of *B*, the abbreviations are Stockhausen's)

- in *C*: IK: section with distinguishable impulses
 IN: section with impulses in a statistical accumulation
- in *F*: the letters refer to the nomenclature of timbral groupings ("Musik und Sprache III," 64–65; Engl. ed. 60); the numbers indicate density

Everything in italics in the following is editorial.

<i>timing</i>	<i>section</i>	<i>text</i>	<i>vocal category</i>
0'00	<i>A</i>	jubelt [jubelt dem Herrn] [preiset den Herrn ihr Werke alle des Herrn] [lobt ihn] lobet ihn [lobt ihn und über alles erhebt ihn] IHN IN EWIGKEIT	sy cs ⁶ cs ⁴ cs ³ sy cs ⁷ vc ⁷ vc ²
1'02	<i>B 1</i>	[jubelt dem Herrn ihr Engel des Herrn] [preiset den Herren] [jubelt den Herrn ihr Himmel droben] [ihr Wasser alle] [preiset/jubelt den(m) Herrn] [die über den Himmeln sind] [alle] [jubelt] [ihr Scharen alle des Herrn] [jubelt dem Herrn ihr Scharen alle des Herrn preist ihn alle ihr Scharen]	cs ⁵ cs ¹ cs ² cs ⁴ cs ⁶ cs ³ cs ⁷ cs ⁵ cs ² cs ¹
1'43	<i>2</i>	<i>permutation of the cs of A and B1</i> [ihr Wasser alle] [lobt ihn] [jubelt dem Herrn] [die über den Himmeln sind] [preiset den Herrn] [preiset/jubelt den(m) Herrn] [ihr Scharen alle des Herrn] [preiset den Herrn ihr Werke alle des Herrn] [jubelt] [jubelt dem Herrn ihr Himmel droben]	cs ⁴ cs ³ cs ⁶ cs ³ cs ¹ cs ⁶ cs ² cs ⁴ cs ⁵ cs ²

2' 24	3	<i>in superposition: one cs per loudspeaker</i>		
		[lobt ihn und über alles erhebt ihn]	cs ⁷	
		[jubelt dem Herrn ihr Engel des Herrn]	cs ⁵	
		[jubelt dem Herrn ihr Scharen alle des Herrn	cs ¹	
		preist ihn alle ihr Scharen]		
		<i>partial cs</i>		
		[die über den Himmeln sind]	cs ³	
		[jubelt dem Herrn]	cs ⁶	
		<i>in spatial rotation</i>		
		[preis(e)t den Herrn]	cs ¹	
	C	[ihr Scharen alle des Herrn]	cs ²	
		lobet ihn	sy	
		[ihr Wasser alle]	cs ⁴	
		[alle] <i>in four loudspeakers</i>	cs ⁷	
		ihn	sy	
		<i>each section begins with a swarm of impulses</i>		
		<i>or with cs assimilated to these swarms</i>		
		preist den Herrn Son ne und Mond	sy	
		<i>impulse swarm alone</i>		
		<i>in 3 loudspeakers</i>		
2' 43	IK	preiset den Herrn	sy	
3' 17	IN1	des Himmels	sy	
3' 36	IK	Sterne	sy	
		al ler Re gen und Tau	sy	
		den Herrn preist	sy	
4' 29		<i>impulse swarm alone</i>		
4' 31	IN1	[preis(e)t/jubelt den(m) Herrn]	cs ⁶	
4' 43	IK	ihr Win de	sy	
4' 49	IN2	[ihr Wasser alle]	cs ⁴	
4' 52	IN1	[lobt ihn]	cs ³	
4' 59	IN2			
5' 13	D α	<i>over a background of B2 (tracks 3 to 5)</i>		
		<i>played backwards</i>		
		DEN HERRN PREISET	vc	
		FEUER UND SOMMERSGLUT	vc	
		PREISET DEN HERRN	vc	
5' 56	β	Kälte und starrer Winter	sy	
	E	<i>vocal parts inserted</i>		
6' 21				
6' 51	1	[preis(e)t den Herrn Tau und des Regens Fall]	vp ³	
7' 02				
7' 17	2	[preis(e)t den Herrn Frost und Eis]	vp ⁵	
7' 26				
7' 51	3	[preis(e)t den Herr(e)n Reif und Schnee]	vp ⁴	
8' 07				

8'14 8'21	4	[preiset den Herrn Nächte und Tage]	vp ²
8'39	F D4	ju belt dem Herrn dem Her ju bel <u>tuj</u> ult ren Herrn belt tuj leb ju dem jeb leb ju be dem Herrn tuj lt bel dem ju dem <u>ihr</u> Herrn Herrn belt Wer ke al le des Herrn	sy/sm1 sy/sm2 sy/sm3 sy/sm4 sy/sm5 sy/sm6
9'00	H8	al i (h)ir des le Her Wer ren ke <u>des</u> Wer al ihr <u>Herrn</u> le ke Wer a des <u>ihr</u> (h)al Her ke ren le al le des Her ren Wer ke ihr	sy/sm9 sy/sm10 sy/sm12 sy/sm13 sy/sm14 sy/sm15
9'12	R6	HERRN	vc
9'20	N10	preist und Eis Eis Reif und Frost ZE Re STRA gens	sy sy+vc
9'42	V2	PREISET DEN HERRN LICHT UND DUNKEL	vc
9'49	L12	den HERRN jubelt	sy+vc
9'53	<i>beginning of the first rhythmic insert</i>		
		BLI ZE ihr alle STRA tuj LEN über alles und WOL KEN	sy+vc
10'03	F6	droben [sm15'] ihr Scharen alle [sm10'] jubelt [sm14'] dem Herren jubelt ihr	sy+sy/sm sy+sy/sm sy
10'14	B2	[sm5' <i>nine times</i>]	sy/sm
10'26	I10	<i>cs in the background sonority</i> Schnee [sm15'] [ihr Wasser alle] [lobt ihn und über alles erhebt ihn] Frost [alle] [lobt ihn] und	sy+sy/sm cs ⁴ cs ⁷ sy cs ⁷ cs ³ sy

		[die über den Himmeln sind]	cs ³
		[jubelt dem Herrn]	cs ⁶
		Eis Glut jubelt Scharen ihr Werke des Herrn	sy
		jubelt	sy
		[jubelt dem Herrn ihr Engel des Herrn]	cs ⁵
		alle und	sy
		[preiset/jubelt den(m) Herrn]	cs
		[jubelt dem Herrn ihr Himmel droben]	cs
		über alles	sy
11'06	P8	BLI ZE DUN KEL	vc
		STRA LEN	vc
11'23	X1		
11'30		<i>end of the first rhythmic insert</i>	
		Schnee ihn (<i>retrograde</i>)	
11'46	T4	FEU ER	vc
11'53	W1	WOL KEN NÄCH TE TA GE [sm9', sm1']	vc+sy/sm
11'57	C3	Reif [sm6', sm12']	sy+sy/sm
12'05	G7		
12'07		<i>beginning of the second rhythmic insert</i>	
		Schnee Bli ze Bli Reif Bli ze ze preiset	sy
		den Herren	sy
		ihr Scharen die über	sy
		Himmels und sind	sy
		[sm5'] alle [sm5']	sy+sy/sm
12'10	K11	jubelt dem Herrn	sy
		[sm5'] ihr Engel	sy+sy/sm
		[sm5'] preiset den Herren [sm5' two times]	sy+sy/sm
12'22	S5	LICHT	vc
12'25	O9	SOMMERSGLUT	vc
12'27	M11	lobet [sm5', sm8'] preist	sy+sy/sm
		glut Stra len Licht Wol	sy
		ken LICHT Bli ze ju-bel und über alles	sy+av
		erhebt ihn	
12'34		<i>end of the second rhythmic insert</i>	

Coda	TAU [sm5'] [sm13'] <i>in the final chord</i>	vc+sy/sm sy/sm
12'54		

NOTES

Various elements contained in the more general parts of this article have been presented in various earlier publications (particularly: "Son pur—bruit—méditations. Matières, matériaux et formes dans *Gesang der Jünglinge* de Karlheinz Stockhausen," *Genesis* 4 (1993): 69–85). The serial issues have only been touched on. The present study is based on an investigation of the composer's sketches, such as were made accessible in a limited edition published in 1983, and which was carried out within the framework of a grant from the Paul Sacher Foundation in Basel, which we wish to thank for its hospitality and generosity.

1. Karlheinz Stockhausen, "Situation des Handwerks," *Texte* 1 (Cologne: Verlag DuMont Schauberg, 1963), 23.
2. See the articles on this subject by Pierre Boulez and Henri Pousseur in *Die Reihe* 1: *elektronische Musik* (1955; English edition 1958), as well as their correspondence from the spring of 1954 (deposited in the Paul Sacher Foundation, Basel).
3. Karlheinz Stockhausen, "Situation du métier de compositeur," *Domaine musical* 1 (1954): 140; "Situation des Metiers," *Texte* 1, 56.
4. "Situation du métier," 141; "Situation des Metiers," 56.
5. The original text, intended for a "Musikalisches Nachtprogramm des Nordwestdeutschen Rundfunks" of 23 December 1954, significantly has as its title: "Von Anton Webern zu Claude Debussy—Formprobleme der elektronischen Musik."
6. Fritz Winkel, *Klangwelt unter der Lupe* (Berlin/Wundsiedel: Max Hesses Verlag, 1952), 8; French translation as *Vues nouvelles sur le monde des sons* (Paris: Dunod, 1960), 2.
7. Karlheinz Stockhausen, "... wie die Zeit vergeht ...," *Texte* 1, 108–109 [English edition of *Die Reihe* 3:17].

8. Karlheinz Stockhausen, "Aktuelles," *Texte 2* (Cologne: Verlag DuMont Schauberg, 1964), 51–57 [English trans. as "Actualia," *Die Reihe* 1:45–51].
9. Pierre Boulez, "Eventuellement . . .," *Relevés d'apprenti* (Paris: Seuil, 1966), 153–55; *The Boulez-Cage Correspondence*, ed. by Jean-Jacques Nattiez (Cambridge University Press, 1993), 98–103.
10. Stockhausen, "Aktuelles," 54 [English ed., 48].
11. This constitutes a deviation compared to the system (1:2:4:8:16), as is still reflected in the first sketch relating to the temporal organization of the six complexes, where it appears, however, that Stockhausen also means to realize only one layer out of every two—that is, half of the layers contained in each octave of duration. The reasons for this modification must be sought in the means of production. In fact, the synchronization was done starting from monophonic tapes onto a four-track multichannel machine; by a return mixing operation from the multitrack to the monophonic apparatus, the total number of voices could be brought to sixteen—exactly the number of layers in complex V as it was realized. Along with the very laborious realization of the sixteen additional layers, the theoretical proportions would have always implied new copying operations, which would have meant a notable increase in background noise each time as well.
12. Stockhausen, "... wie die Zeit vergeht . . .," 108–9 and 122–23 [English edition of *Die Reihe* 3:17 and 27–28]. For an explication of applications in *Zeitmaße* and *Gruppen*, cf. Pascal Decroupet, "Gravitationsfeld *Gruppen*. Zur Verschränkung der Werke *Gesang der Jünglinge*, *Gruppen* und *Zeitmaße* und deren Auswirkung auf Stockhausens Musikdenken in der zweiten Hälfte der fünfziger Jahre," *Musiktheorie* 12, no. 1 (1997): 37–51.
13. A transcription of the corresponding sketch may be found in Elena Ungeheuer, "Statistical Gestalts—Perceptible Features in Serial Music," *Music, Gestalt, and Computing (Lecture Notes in Artificial Intelligence 1317)*, ed. Marc Leman (Berlin: Springer, 1997), 107.
14. A version of the present Example 2 with the timbres included may be found in Elena Ungeheuer, "From the Elements to the Continuum: Timbre Composition in Early Electronic Music," *Contemporary Music Review* 10, no. 2 (1994): 27.

15. The vocal material has been augmented by the word "Strahlen"; the calls of "jubelt" and "preis(e)t," which are synonymous, are freely interchanged.
16. Cf. Karlheinz Stockhausen, "Musik und Sprache III," *Texte* 2, 68 [English trans. as "Music and Speech," *Die Reihe* 6:63]; the durations depicted and notated are the durations actually realized; originally, all of the layers were to have had a duration of 210 cm, which is about three seconds.
17. The process of realization is described by Stockhausen in "Wille zur Form und Wille zum Abenteuer [Gespräch mit Rudolf Frisius]," *Texte* 6 (Cologne: DuMont Buchverlag, 1989), 338; cf. also the sketch transcriptions in Richard Toop, "Stockhausen's Electronic Works: Sketches and Work-Sheets from 1952-1967", *Interface* 10 (1981): 180-82.
18. A transcription of the first two pages of Stockhausen's second realization score was published by Richard Toop in "Stockhausen's Electronic Works," 178-79; this same transcription is reproduced in Robin Maconie, *The Works of Karlheinz Stockhausen*, 2d ed. (Oxford: Clarendon Press, 1990), 60-61.
19. This reduction shows the five loudspeakers vertically, the temporal sequence of events horizontally. The overall duration is 3' 13". The logic of spatial link-up confirms that the five loudspeakers were located according to the same plan, around the audience, and that speculations concerning one loudspeaker placed above the audience are purely a matter of myth.
20. The durations of the sections according to the scale: 128-210-344-565-928-1520-2496-4096 cm; the final section, with a length of 1066 cm, is at the same time the beginning of part *D* and no longer fits into this scale. The spacing for the vocal sounds follows the scale: 43.1-70.7-116-190.2-312-512-840 cm (applied three times). The two collections of groups of deep sounds draw the values for their spacing from the scale 26.3-43.1-70.7-116-190.2-312.1-512 cm, values which are multiplied by 4.5 to yield a total corresponding approximately to the total duration of this part.
21. The values in parentheses come from the 7×7 square of basic durations. The first terms constitute a scale progressing by whole seconds, the second ones by half-seconds. As before, these values are approximate, because Stockhausen caused to intervene as a supplementary criterion the presence of all the classes of durations, that is,

of all the columns of the table (except that in the scale of half-seconds a doubling of column 2 occurs, compensating for the absence of column 3). The scale of dotted values results from their combination. The alternation between the scales follows those of the base elements and of the figures (or high noises): in the sections with distinct impulses, the alternation operates between the scales of seconds (presence of a noisy background) and of half-seconds (absence of a noisy background); in the sections with statistical impulses, the areas coming from the scale of dotted values are marked by bands of high noises, and they alternate with areas in which the durations are extracted from the scale of half-seconds.

22. Karlheinz Stockhausen, "Musik im Raum," *Texte* 1, 161 [English trans. as "Music in Space," *Die Reihe*, 5:73].
23. Figure 28 (marked with an x in Example 6) consists of two isolated impulses in a descending melodic direction, right after the words "ihr Winde." Since there is no noise-band in the background, this figure does not integrate into the grouping strategy.
24. The initial x is equivalent to 195 cm, the unit of subdivision for this layer.
25. The continuation of this vocal polyphony is contained in "Musik und Sprache III," 67 [English ed. of *Die Reihe* 6:62].
26. The sketches of the unrealized part *G* show that Stockhausen had derived the pitches for the vocal as well as the electronic elements from this same scale, read in a cycle of interval 5.
27. A transcription of this sketch has been published in Elena Ungeheuer, "Statistical Gestalts," 111.
28. "Musik und Sprache III," 64 [English ed. 59–60].
29. "Musik und Sprache III," 64–65 [English ed. 60].
30. See also "Musik und Sprache III," 65 [English ed. 61].
31. "Musik und Sprache III," 61–62 [English ed. 58–59].
32. The extract relating to a study score was published in Pascal Decroupet, "Timbre Diversification in Serial Tape Music and its Consequence on Form," *Contemporary Music Review* 10, no. 2 (1994): 19.
33. "Musik und Sprache III," 65 [English ed. 60].